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(54) **APPARATUS AND METHOD FOR GENERATING ON-SCREEN-DISPLAY MESSAGES USING FIELD DOUBLING**

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(52) **U.S. Cl.** **348/569**; 348/589; 348/600; 348/461; 348/467; 348/468; 348/469

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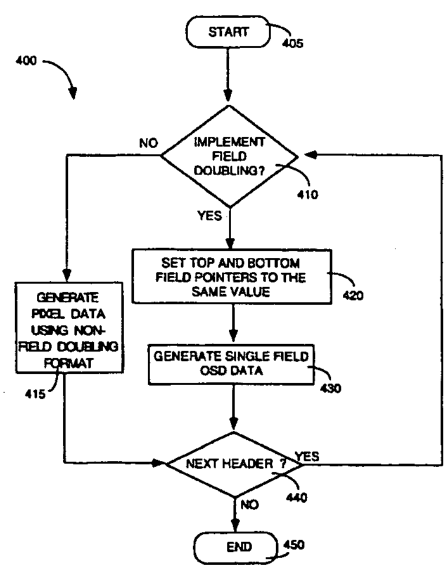
(57) **ABSTRACT**

An apparatus and concomitant method for generating an OSD message by constructing an OSD bitstream defining a single field of OSD data. The OSD bitstream contains an OSD header and OSD data. An OSD unit retrieves pixel control information from the OSD header which is programmed by a processor of a decoding/displaying system. The OSD header contains information including various pointers, that are used to provide instructions as to the treatment of the OSD data. If a top field pointer and a bottom field pointer are set to an identical value in the OSD header, then the OSD unit will repeat each OSD line in the other field for an OSD region.

10 Claims, 4 Drawing Sheets



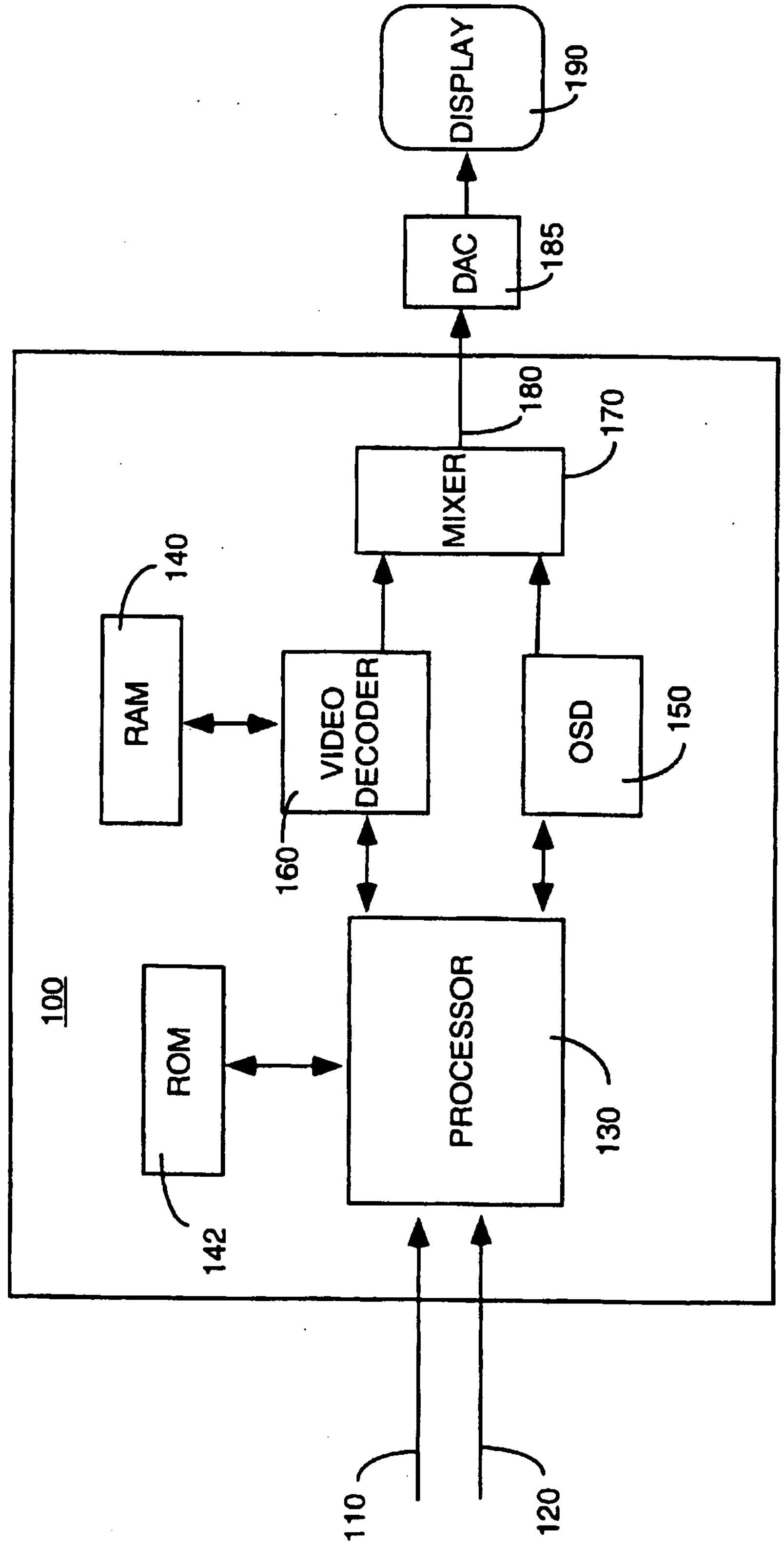

DISPLAY
190
DAC
185
180
170
MIXER
140
RAM
VIDEO DECODER
160
OSD
150
100
ROM
PROCESSOR
130
142
110
120

FIG. 1

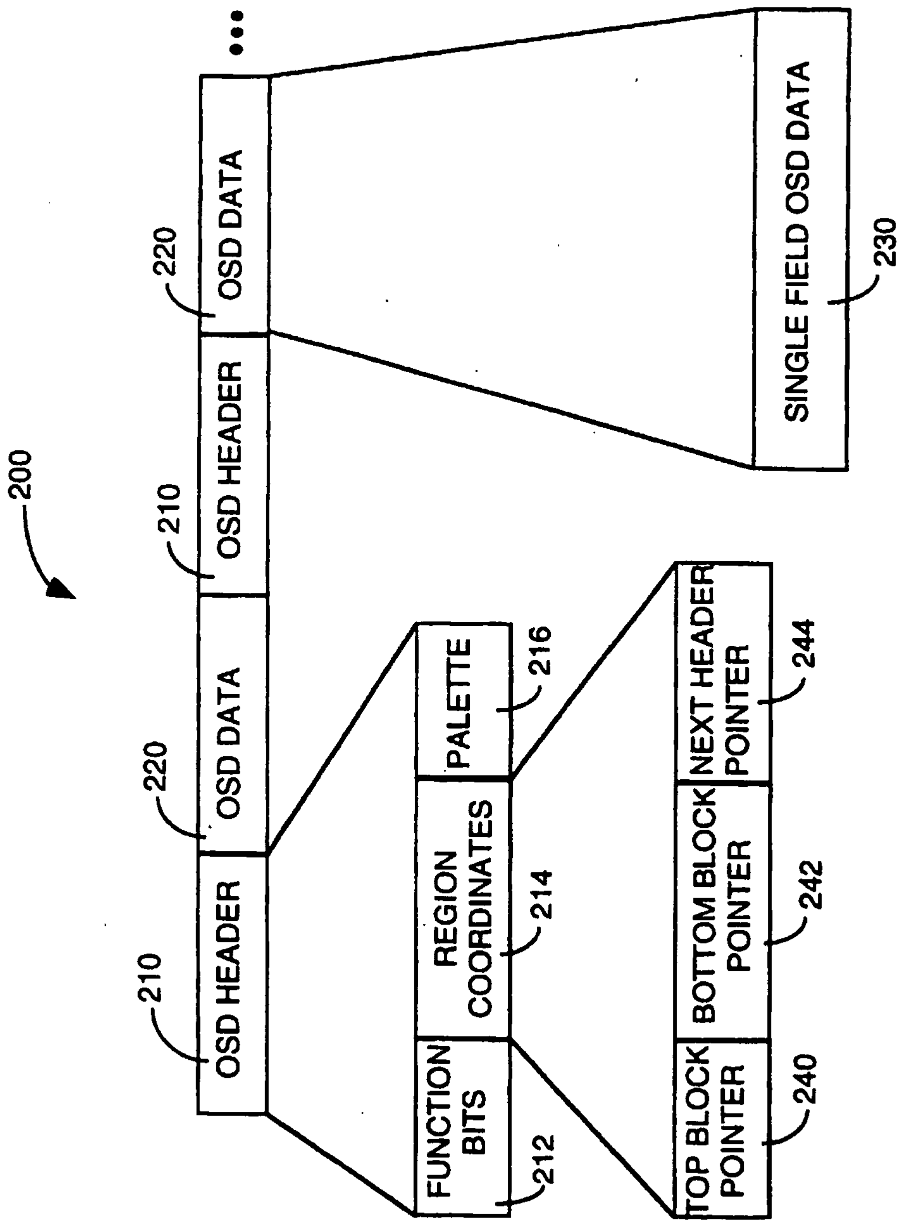

200
210
OSD HEADER
220
OSD DATA
210
OSD HEADER
220
OSD DATA
SINGLE FIELD OSD DATA
230
FUNCTION BITS
212
REGION COORDINATES
214
PALETTE
216
TOP BLOCK POINTER
240
BOTTOM BLOCK POINTER
242
NEXT HEADER POINTER
244

FIG. 2

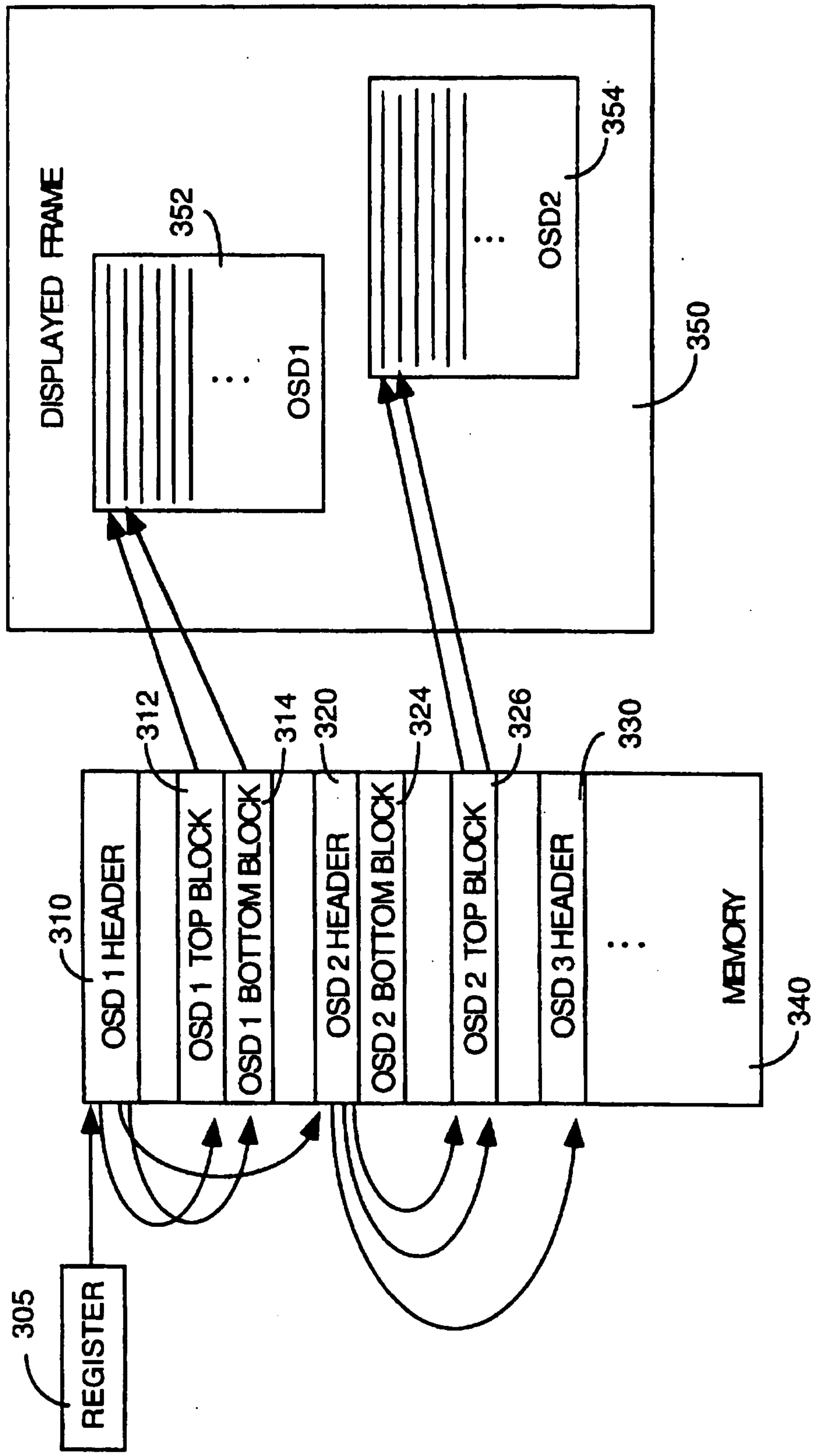

DISPLAYED FRAME
352
OSD1
354
OSD2
350
312
314
320
324
326
330
310
OSD 1 HEADER
OSD 1 TOP BLOCK
OSD 1 BOTTOM BLOCK
OSD 2 HEADER
OSD 2 BOTTOM BLOCK
OSD 2 TOP BLOCK
OSD 3 HEADER
MEMORY
340
305
REGISTER

FIG. 3

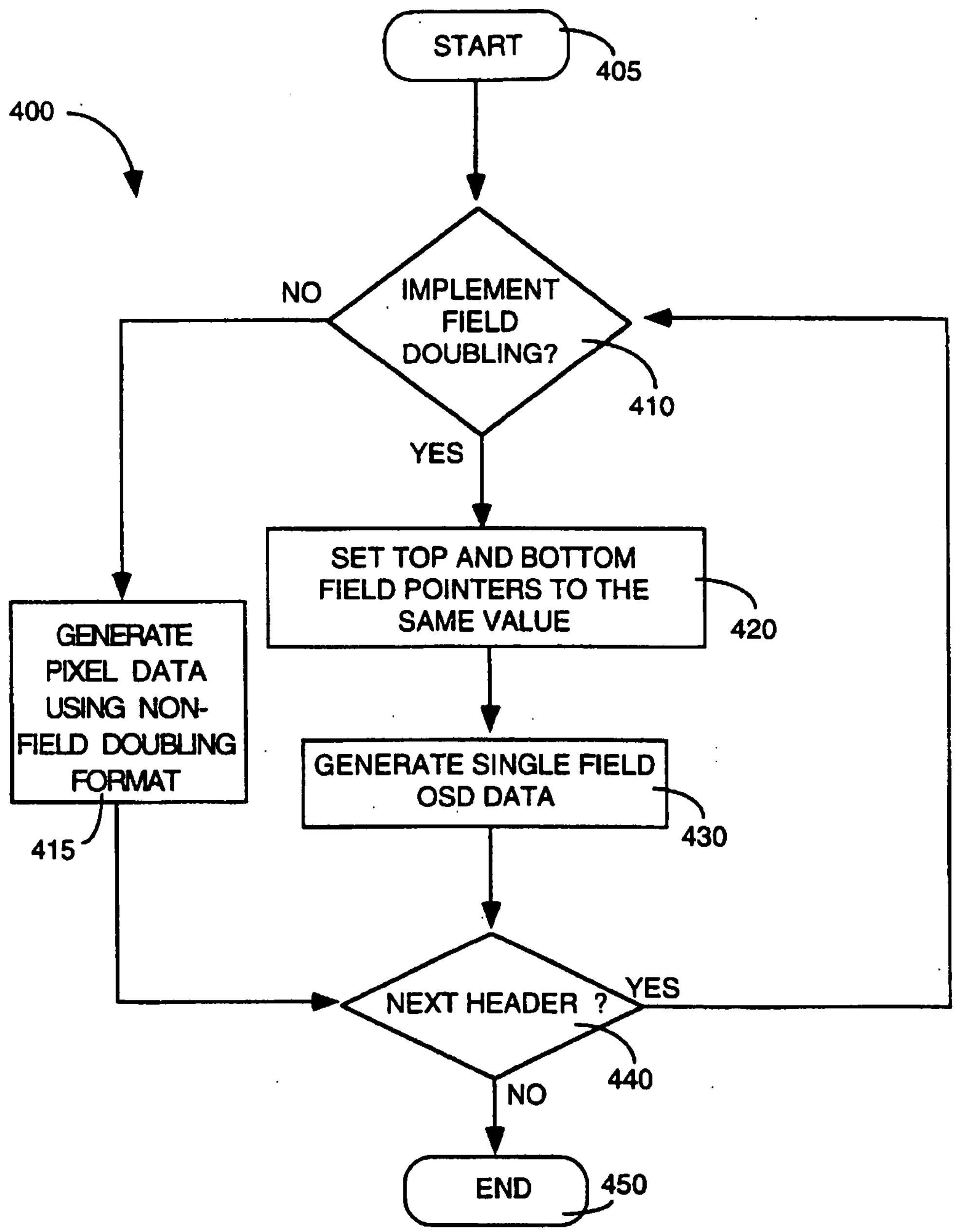

START
405
400
IMPLEMENT FIELD DOUBLING?
NO
410
YES
SET TOP AND BOTTOM FIELD POINTERS TO THE SAME VALUE
420
GENERATE PIXEL DATA USING NON-FIELD DOUBLING FORMAT
415
GENERATE SINGLE FIELD OSD DATA
430
NEXT HEADER ?
YES
440
NO
END
450

FIG. 4

APPARATUS AND METHOD FOR GENERATING ON-SCREEN-DISPLAY MESSAGES USING FIELD DOUBLING

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for generating On-Screen-Display (OSD) messages using a field doubling mode. More particularly, this invention relates to a method and apparatus that reduces the memory bandwidth requirements of a decoding/displaying system by repeating a top field of OSD data in the bottom field for an OSD region.

BACKGROUND OF THE INVENTION

On-Screen-Display messages play an important role in consumer electronics products by providing users with interactive information such as menus to guide them through the usage and configuration of the product. Other important features of OSD include the ability to provide Closed Captioning and the display of channel logos.

However, the heightened standard of digital video technology presents an ever increasing problem of generating and displaying OSD messages. For example, there are specific High Definition Television (HDTV) requirements that an HDTV must display up to 216 characters in four (4) "windows" versus the current National Television Systems Committee (NTSC) requirements of a maximum of 128 characters in one "window". These new requirements place severe strains on the decoding/displaying system used to decode and display television signals (e.g., HDTV, NTSC, MPEG, and the like), which must decode the incoming encoded data streams and present the decoded data to a display system with minimal delays. Since OSD messages must be displayed (overlaid) with the video data, the microprocessor of the decoding/displaying system must assign a portion of the memory bandwidth to perform OSD functions, thereby increasing the memory bandwidth requirements of a decoding/displaying system and the overall computational overhead.

WO 90/15502 discloses a method and apparatus for superimposing information upon video signals and the like. Data which is to be combined with a composite video signal is stored in a replaceable memory device. A composite (e.g. television) signal is provided to an input. Horizontal and vertical sync signals are separated at a separator and then used to synchronize the reading functions from memory. In addition to display information, the data stored in memory includes frame count, line count and positional information by which initiation, line location and within-line position, respectively, of the display information are determined. The display information may include subliminal, supraliminal or both; and may be displayed repeatedly. A similar technique is employed to combine sound data with audio signals.

Thus, a need exists for a method and apparatus for generating On-Screen-Display (OSD) messages without increasing the hardware requirements, e.g., memory bandwidth, of a decoding/displaying system.

SUMMARY OF THE INVENTION

The invention concerns an apparatus and concomitant method for generating OSD messages by constructing a valid OSD bitstream with instructions in the OSD header to repeat a top field of OSD data in the bottom field for an OSD region.

More specifically, in accordance with the invention, an OSD unit retrieves an OSD bitstream from a storage device. The OSD bitstream contains an OSD header and OSD data. The OSD header contains control information that is used to program a color palette of the OSD unit and to provide instructions as to the treatment of the OSD data. The control information is programmed by a processor of a decoding/displaying system.

The control information includes two OSD pixel data pointers, an "OSD Top Block Pointer" and an "OSD Bottom Block Pointer". These pointers (flags) inform the OSD unit where the top and bottom OSD pixel data are located respectively in the memory. By setting both pointers to the same value, the OSD unit repeats an OSD line of pixels in the other field. Namely, the top and bottom fields share the same OSD data.

These and other aspects of the invention will be described with respect to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

In the Drawings:

FIG. 1 is a block diagram of a decoding/displaying system including an OSD unit in accordance with an aspect of the invention;

FIG. 2 illustrates the structure of a sample OSD bitstream **200** implementing Field Doubling;

FIG. 3 is a block diagram which discloses the structure of a memory having various OSD headers and OSD top and bottom field bit maps (blocks) and their relationships to a displayed frame; and

FIG. 4 is a flowchart illustrating the method for constructing a valid OSD bitstream implementing Field Doubling.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a block diagram of a decoding/displaying system for television signals **100** (hereinafter decoding system). The decoding system comprises a processor **130**, a random access memory (RAM) **140**, a read-only memory (ROM) **142**, an OSD unit **150**, a video decoder **160**, and a mixer **170**. The output of the mixer **170** is coupled to a display device **190** via path **180**.

The present invention is described below in accordance with the MPEG standards, ISO/IEC international Standards 11172 (1991) (generally referred to as MPEG-1 format) and 13818 (1995) (generally referred to as MPEG-2 format). However, those skilled in the art will realize that the present invention can be applied or adapted to other decoding systems implementing other encoding/decoding formats.

In the preferred embodiment, the decoding system **100** performs real time audio and video decompression of various data streams (bitstreams) **120**. The bitstreams **120** may comprise audio and video elementary streams that are encoded in compliance with the MPEG-1 and MPEG-2 standards. The encoded bitstreams **120** are generated by an encoder (not shown) and are transmitted to the decoding system through a communication channel. The encoded bitstreams contain a coded representation of a plurality of images and may include the audio information associated with those images, e.g., a multimedia data stream. The multimedia source may be a HDTV station, a video disk, a cable television station and the like. In turn, the decoding system **100** decodes the encoded bitstreams to produce a plurality of decoded images for presentation on the display **190** in synchronization with the associated audio information. However, for the purpose of this invention, the audio

decoding function of the decoding system **100** is irrelevant and, therefore, not discussed.

More specifically, processor **130** receives bitstreams **120** and bitstreams **110** as inputs. Bitstreams **110** may comprise various control signals or other data streams that are not included in the bitstreams **120**. For example, a channel decoder or transport unit (not shown) can be deployed between the transmission channel and the decoding system **100** to effect the parsing and routing of data packets into data streams or control streams.

In the preferred embodiment, processor **130** performs various control functions, including but not limited to, providing control data to the video decoder **160** and OSD unit **150**, managing access to the memory and controlling the display of the decoded images. Although the present invention describes a single processor, those skilled in the art will realize that the processor **130** may comprise various dedicated devices to manage specific functions, e.g., a memory controller, a microprocessor interface unit and the like.

Processor **130** receives bitstreams **120** and writes the data packets into the memory **140** via video decoder **160**. The bitstreams may optionally pass through a First-In-First-Out (FIFO) buffer (not shown) before being transferred via a memory data bus to the memory. Furthermore, there is generally another memory (not shown) which is used solely by the processor **130**.

The memory **140** is used to store a plurality of data including compressed data, decoded images and the OSD bit map. As such, the memory is generally mapped into various buffers, e.g., a bit buffer for storing compressed data, an OSD buffer for storing the OSD bit map, various frame buffers for storing frames of images and a display buffer for storing decoded images.

In accordance with the MPEG standards, the video decoder **160** decodes the compressed data in the memory **140** to reconstruct the encoded images in the memory. In some cases, the decoded image is a difference signal that is added to a stored reference image to produce the actual image in accordance with the compression technique used to encode the image (e.g., to facilitate decoding a motion compensated image). Once an image is reconstructed, it is stored in the display buffer pending display via the mixer **170**.

Similarly, the OSD unit **150** uses the memory **140** to store the OSD bit map or the OSD specification. The OSD unit allows a user (manufacturer) to define a bit map for each field which can be superimposed on the decoded image. The OSD bit map may contain information which is stored in a storage device, e.g., a ROM, concerning the configuration and options of a particular consumer electronics product. Alternatively, the OSD bit map may contain information relating to Closed Captioning and channel logos that are transmitted from a cable television, a video disk and the like. An OSD bit map is defined as a set of regions (generally in rectangular shapes) of programmable position and size, each of which has a unique palette of available colors.

The OSD bit map is written into the OSD buffer of the memory **140** which is assigned for this purpose by the user. However, those skilled in the art will realize that a ROM **142** or other equivalent storage devices can also serve this function as well.

When the OSD function is enabled for a particular image or frame, the processor **130** manipulates the data in memory **140** to construct an OSD bitstream. The OSD bitstream contains an OSD header and OSD data (data defining the OSD pixels).

More specifically, the processor **130** programs (formats and stores) the OSD header in the memory **140**. The OSD header contains information concerning the locations of the top and bottom OSD field bit maps, palette data, pointer to the next header block and various display modes involving OSD resolution, color and compression. Once the OSD header is programmed, the processor **130** may manipulate the OSD data in the memory **140** in accordance with a particular implementation. Alternatively, the processor may simply program the OSD header with pointers to the OSD data in the memory, where the stored OSD data is retrieved without modification to form the OSD bitstream. A detailed description of the various OSD pointers is discussed below with reference to FIG. **2**.

The processor **130** then reports the enable status, e.g., OSD active, to the OSD unit **150**, which responds by requesting the processor **130** for access to the OSD bitstream stored within the memory **140**. The OSD bitstream is formed and retrieved as the OSD unit **150** reads the OSD headers, each followed by its associated OSD data. After receiving the OSD bitstream, the OSD unit processes the OSD pixel data in accordance with the instructions or selected modes in the OSD header. The OSD unit then waits for a pair of display counters (not shown) to attain count values that identifies the correct position on the display for inserting the OSD information (messages). At the correct position, the OSD unit forwards its output to the mixer **170**. The output of the OSD unit **150** is a stream or sequence of digital words representing respective luminance and chrominance components of the on screen display. New memory accesses are requested as required to maintain the necessary data flow (OSD bitstream) through the OSD unit to produce a comprehensive OSD display. When the last byte of the OSD pixel data for the current OSD region is read from the memory, the next OSD header is read and the process is repeated up through and including the last OSD region for the current frame.

Those skilled in the art will realize that the order of constructing and retrieving the OSD bitstream as discussed above can be modified. For example, the OSD header can be read from the memory as the processor is formatting the OSD data, or the OSD data can be processed and displayed as OSD messages by the OSD unit without having to retrieve the entire OSD bitstream.

Since OSD pixel data is superimposed on the decoded image, the mixer **170** serves to selectively blend or multiplex the decoded image with the OSD pixel data. Namely, the mixer **170** has the capability to display at each pixel location, an OSD pixel, a pixel of the decoded image or a combination (blended) of both types of pixels. This capability permits the display of Closed Captioning (OSD pixel data only) or the display of transparent channel logos (a combination of both OSD pixels and decoded image pixels) on a decoded image.

Video decoder **160** and OSD unit **150** both form streams or sequences of digital words representing respective luminance and chrominance components. These sequences of video component representative digital words are coupled via mixer **170** to a digital-to-analog converter (DAC) **185**. The luminance and chrominance representative digital words are converted to analog luminance and chrominance signals by the respective sections of the DAC.

The OSD unit **150** can be used to display a user defined bit map over any part of the displayable screen, independent of the size and location of the active video area. This bit map can be defined independently for each field and specified as

a collection of OSD regions. A region is often a rectangular area specified by its boundary and by a bit map defining its contents. The bit map is displayed in a plurality of OSD lines, where each OSD line represents a line of OSD pixels in an OSD region. Each region has associated with it a palette defining a plurality of colors (e.g., 4 or 16 colors) which can be used within that region. If required, one of these colors can be transparent, allowing the background to show through as discussed above.

However, handling the OSD functions for a frame increases the computational overhead of the processor **130** and, more importantly, places severe strains on the memory bandwidth of the processor because the processor **130** must service memory requests from both the video decoder **160** and the OSD unit **150**. As such, the present invention reduces the size of the OSD bitstream by implementing the Field Doubling Mode. By repeating each OSD line for both top and bottom fields, the amount of OSD data that must be stored and read from the memory **140** is reduced by 50%.

FIG. 2 illustrates the structure of a sample OSD bitstream **200** implementing "Field Doubling". The OSD bitstream comprises a plurality of OSD headers **210**, each followed by OSD data **220**. In one embodiment, the header is comprised of five 64-bit words, followed by any number of 64-bit OSD data (bit map) words. The OSD header **210** contains information relating to the OSD region coordinates **214**, the various entries of the palette **216** for a particular OSD region, and various function codes (bits) **212**. Those skilled in the art will realize that the OSD header can be of any length. A longer header can provide more information and options, e.g., a palette with more entries, but at the expense of incurring a higher computational overhead, i.e., more read and write cycles are required to implement the OSD functions. In fact, the content of the OSD header is illustrative of a particular embodiment and is not limited to the specific arrangement as illustrated in FIG. 2.

The palette **216** contains a plurality of entries where each entry contains a representation of chrominance and luminance levels for an OSD pixel. The palette information **216** is used to program the OSD palette.

The function codes (bits) **212** contain information relating to various modes, including but not limited to, display options and OSD bitstream options. The selection of the function codes **212** is controlled by the processor **130**.

The OSD region coordinates **214** contain the positions of the left and right edge of an OSD region, i.e., row start and stop positions and column start and stop positions. These coordinates defines the location where an OSD region will appear on a displayed frame.

However, a conventional television display employs an interlaced display technique, a form of subsampling, where every other line of an image is initially displayed (scanned). Once the initial scan is completed, a second scan of the remaining set of lines is conducted starting from the top of the image. Namely, the odd numbered lines (generally referred to as "top field" or "top block") of an image or frame is initially scanned, followed by a succeeding scan of the even numbered lines (generally referred to as "bottom field" or "bottom block") at a later time. For interlaced display, the region coordinates **214** include the positions (pointers) of the top **240** and bottom **242** field pixel bit maps in the memory **140** for the corresponding OSD region. Finally, the OSD region coordinates **214** include a "next header pointer" **244** for pointing to the next header block in the memory **140**.

In the preferred embodiment, the processor **130** can selectively set the top block pointer **240** to the same value as the bottom block pointer **242**. This setting causes the OSD unit **150** to interpret the locations of the OSD data for both the top and bottom fields to be located in the same memory location. This setting causes the OSD unit **150** to display the same OSD data for both top and bottom fields in an OSD region. In essence, the OSD unit repeats an OSD line of pixels in the other field (Field Doubling). As such, the processor **130** is only required to generate one-half of the OSD data. Namely, the size of the OSD bitstream is reduced by approximately 50%.

The OSD data **220** contains bit map data in left to right and top to bottom order. The OSD data is generally used to define the color index to the OSD palette for each pixel in the bit map imagery. If Field Doubling is implemented for an interlaced display, the OSD data **220** defines OSD data for only a single field **230**. Since the top and bottom block pointers are set to the same value, the OSD unit **150** only needs to read a single field of OSD data versus two fields. The decision as to which field (top or bottom) to repeat, is determined by the processor **130**. Generally, the selection of one field over another would not produce a noticeable difference.

FIG. 3 illustrates a block diagram which discloses the structure of a memory **340** having various OSD headers and OSD top and bottom field bit maps (blocks) **310–330** and their relationships to a displayed frame **350** having a plurality of OSD regions **352** and **354**. To illustrate, for each "OSD active" frame, the OSD unit **150** requests memory accesses starting at the memory location pointed to by the register **305**. The OSD unit **150** reads the first OSD header block **310** to determine where the top **312** and bottom **314** OSD field bit maps are located for an OSD **1** region **352**. When the OSD data from both fields are read by the OSD unit, the OSD unit sends a new header address to the processor **130** using the "next header pointer" which is stored in the first OSD header **310**. This process continues until the last OSD region is processed and displayed for the current displayed frame.

FIG. 3 illustrates an OSD **2** region **354**, where Field Doubling is implemented. The OSD unit **150** reads the second OSD header block **320** to determine where the top **326** and bottom **324** OSD field bit maps are located for an OSD **2** region **354**. Since the top and bottom block pointers are set to the same value, the OSD unit **150** only reads a single field (top field **326**) of OSD data. The single field of OSD data is repeated for the OSD **2** region **354**. The bottom OSD field bit map **324** is neither used nor read from the memory. In fact, for certain type of OSD data, the processor **130** may not construct the bottom OSD field bit map **324** at all.

This mode of operation allows the processor **130** to gain a 2:1 compression ratio over the normal display mode where the OSD bitstream carries both fields of OSD data. The saving is more significant where the OSD regions are particularly large. If Field Doubling is implemented, the OSD display resolution is vertically reduced by 50%, since each successive pair of horizontal OSD lines displays the same information.

However, a reduction in OSD resolution in exchange for a higher OSD message display rate is acceptable and appropriate for various OSD implementations, e.g., Closed Captioning. Closed Captioning requires the rapid display of OSD messages that generally correlate to words spoken for a series of frames (images). Since it is desirable to view the Closed Captioning as the images are displayed, the reduction in resolution is an acceptable tradeoff. Furthermore,

since the OSD messages within the Closed Captioning are displayed only briefly, the reduced resolution is generally not noticeable. Thus, the Field Doubling decreases the number of memory operations without limiting the display capabilities of a particular OSD implementation.

Finally, although Field Doubling may be implemented for one OSD header **210**, the OSD unit **150** supports multiple header blocks which can each have a different resolution mode. Thus, the OSD unit is able to display different types of resolution or formats on the same video screen. For example, different OSD regions can be displayed in different resolutions depending on the OSD data being displayed.

The implementation of the Field Doubling is controlled by the user via the processor **130**. This control can be implemented using software that detects the need to minimize memory access by the OSD unit **150**. For example, the video decoder **160** may receive a series of complicated encoded frames that require additional memory access. To minimize memory access conflicts between the OSD unit and the video decoder, the processor can offset the increased demand of the video decoder by implementing Field Doubling in the OSD bitstream.

Finally, an alternate embodiment of the present invention incorporates a single bit in the OSD header to indicate whether the "Field Doubling Mode" is enabled. When this dedicated bit is enabled, the OSD unit will repeat the OSD data such that each OSD line is repeated in the other field.

FIG. **4** illustrates a method **400** for constructing an OSD bitstream for implementing Field Doubling. The method is generally recalled from a storage device, e.g., a memory, and executed by the processor **130**. The OSD bitstream is generated by the processor **130** and is processed by the OSD unit **150**. Method **400** constructs an OSD bitstream by generating an OSD header having a plurality of control information including various pointers, followed by a plurality of data bytes.

Referring to FIG. **4**, the method **400** begins at step **405** and proceeds to step **410** where method **400** determines whether the Field Doubling is enabled for an OSD region. If the query is negatively answered, method **400** proceeds to step **415** where the OSD data bytes are generated using a non-field doubling format. Method **400** then proceeds to step **440**.

If the query at step **410** is affirmatively answered, method **400** proceeds to step **420** where the top and bottom field points are set to the same value in the OSD header. Since the top and bottom field (block) pointers are set to the same value, the OSD unit **150** will only need to read a single field of OSD data.

In step **430**, a single field of OSD data is disposed within the OSD data bytes. Namely, the OSD bitstream only carries OSD data for every other OSD line, where each OSD line comprises sufficient OSD pixels for the OSD unit **150** to display a single horizontal line in an OSD region.

In step **440**, method **400** determines whether there is another OSD header. A new OSD header may be required if the various modes represented by the function bits **212** are modified. Similarly, a new header is required for each new OSD region on a frame. If the query is negatively answered, method **400** proceeds to step **450** where method **400** ends. If the query is affirmatively answered, method **400** proceeds to step **410** where the steps of **410–430** are repeated for each additional OSD header. In this manner, the OSD bitstream may comprise both field doubling OSD data bytes and non-field doubling OSD data bytes.

There has thus been shown and described a novel method and apparatus for constructing an OSD bitstream that implements field doubling by using a single OSD pixel field. Many changes, modifications, variations and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification and the accompanying drawings which disclose the embodiments thereof. All such changes, modifications, variations and other uses and applications which do not depart from the scope of the invention are deemed to be covered by the invention, which is to be limited only by the claims which follow.

What is claimed is:

1. Method for constructing an On-Screen Display (OSD) bitstream having an OSD header and OSD data, said method comprising the steps of:

setting a first field pointer and a second field pointer to an identical value in the OSD header; and

generating the OSD data including a plurality of OSD data bytes that define an OSD for a single display field, wherein the identical value corresponds to pointer data for accessing the plurality of OSD data bytes that define the OSD for a single display field, whereby the OSD for a single display field is generated for first and second display fields associated with the first and second pointers, respectively.

2. The method of claim **1**, wherein said first field pointer is a top field pointer and said second field pointer is a bottom field pointer.

3. An OSD bitstream stored in a storage medium comprising:

a header having a first field pointer and a second field pointer, wherein said field pointers are set to an identical value; and

a plurality of OSD data bytes defining an OSD for a single display field, wherein the identical value corresponds to pointer data for accessing the OSD data bytes defining the OSD for a single display field, whereby the OSD for a single display field is generated for first and second display field associated with the first and second pointers, respectively.

4. The OSD bitstream of claim **3**, wherein said first field pointer is a top field pointer and said second field pointer is a bottom field pointer.

5. Apparatus for generating an OSD bitstream having an OSD header and OSD data comprising:

a storage medium for storing the OSD header and OSD data; and

a processor coupled to said storage medium, for generating the OSD bitstream in a field doubling mode by setting a first field pointer and a second field pointer in the OSD header to an identical value and, for generating OSD data including a plurality of OSD data bytes that define an OSD for a single display field, and for storing the OSD header in the storage medium, and the OSD data in a location in the storage medium in accordance with the identical value, whereby the OSD data bytes defining the OSD for a single display field is accessed in response to the first and second field pointers.

6. The apparatus of claim **5**, wherein said storage medium is a read only memory (ROM).

7. The apparatus of claim **5**, wherein said storage medium is a random access memory (RAM).

8. The apparatus of claim **5**, wherein said first field pointer is a top field pointer and said second field pointer is a bottom field pointer.

9. Apparatus for generating an OSD message comprising:

a storage medium for storing an OSD bitstream having a header and OSD data;

a processor, coupled to said storage medium, for generating the OSD bitstream in a field doubling mode by setting a first field pointer and a second field pointer to an identical value within said OSD header and, for generating OSD data including a plurality of OSD data bytes that define an OSD for a single display field, and for storing the OSD header in the storage medium, and the OSD data in a location in the storage medium in accordance with the identical value; and

an OSD unit, coupled to the processor and the storage medium, for processing said OSD bitstream to form the OSD message, wherein the OSD unit retrieves the OSD data bytes for the OSD for a single display field from the location in the storage medium in response to the first and second field pointers in the OSD header, whereby the OSD for a single display field is generated for first and second display fields associated with first and second field pointers, respectively.

10. The apparatus of claim 9, wherein said first field pointer is a top field pointer and said second field pointer is a bottom field pointer.

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